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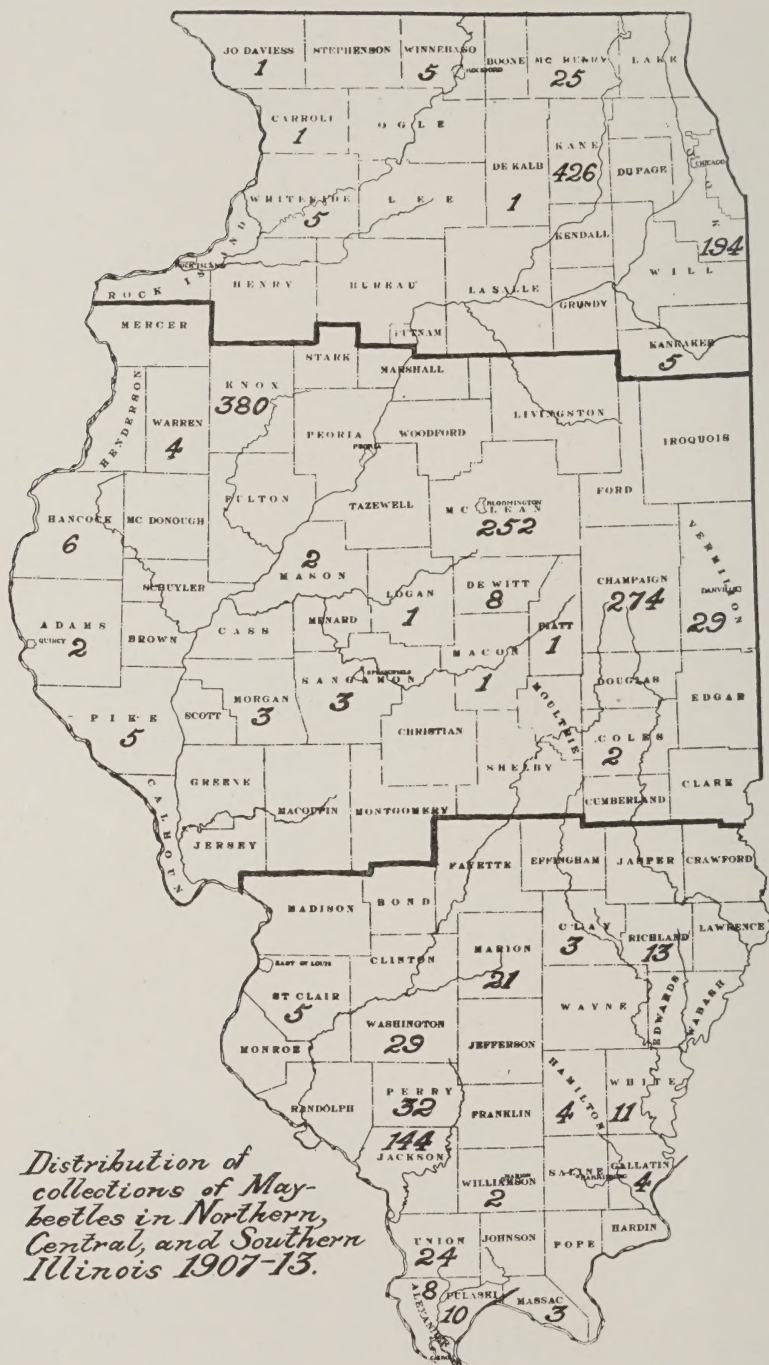
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A GENERAL SURVEY OF THE MAY-
BEETLES (PHYLLOPHAGA)
OF ILLINOIS

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A GENERAL SURVEY OF THE MAY- BEETLES (PHYLLOPHAGA) OF ILLINOIS

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The following discussion is based on a study of the numbers, dates of occurrence, food-plants, and distribution in Illinois of 114,493 May-beetles or "June bugs" belonging to thirty-four species of the genus *Phyllophaga*, and very nearly all collected by my field assistants in forty-two Illinois counties during six of the years from 1907 to 1913, no collections being made in 1912. Occasional use is also made of the data of 4,224 specimens additional, obtained in central Illinois in 1905 and 1906, and two tables of the most important of these collections, that made at Urbana in 1906, are printed with the other statistical summaries. It is the general object of these studies to distinguish the several species of Illinois May-beetles (the parents of the white-grubs); to see which of them are numerous enough anywhere and at any time to be notably injurious in the grub stage to agriculture and horticulture; to learn the food, when in the beetle stage, of these more injurious species; and to learn, so far as practicable, what are the conditions favoring the increase and decrease in numbers of each species, in the not unreasonable hope that a knowledge of these fundamental matters may help, now or eventually, to a solution of the old and very difficult problem of the control of economic injuries by the white-grubs. I have also had especially in view the food habits and preferences of our most abundant May-beetles, as related to the choice of trees and shrubs for roadside planting and for the home premises. Other studies of mine have clearly shown that fields and lawns in the neighborhood of trees upon which May-beetles may feed, are much more liable to injury by the white-grubs than those at some distance from such trees, and it is important, consequently, that those concerned should know what kinds of plants offer special inducements to an infestation of their premises by those destructive insects.

LOCATION OF THE COLLECTIONS

Of the forty-two counties from which collections were obtained thruout the state, nine were in northern, eighteen in central, and fifteen in southern Illinois, those in each section extending well across the state.

COUNTIES IN WHICH COLLECTIONS WERE MADE, AND
NUMBERS OF COLLECTIONS FROM EACH

(TOTAL, 1959 COLLECTIONS)

<i>Northern Illinois</i>	<i>Central Illinois</i>	<i>Southern Illinois</i>
Carroll, 1	Adams, 2	Alexander, 8
Cook, 194	Champaign, 274	Clay, 3
DeKalb, 1	Coles, 2	Gallatin, 4
JoDaviess, 1	DeWitt, 8	Hamilton, 4
Kane, 426	Hancock, 6	Jackson, 144
Kankakee, 5	Iroquois, 8	Marion, 21
McHenry, 23	Knox, 380	Massac, 3
Whiteside, 5	Logan, 1	Perry, 32
Winnebago, 5	McDonough, 4	Pulaski, 10
	McLean, 252	Richland, 13
	Macon, 1	St. Clair, 5
661	Mason, 2	Union, 24
	Morgan, 3	Washington, 29
	Piatt, 1	White, 11
	Pike, 5	Williamson, 2
	Sangamon, 3	
	Vermilion, 29	313
	Warren, 4	
	985	

The localities from which specimens were collected within these counties were twenty in northern, forty in central, and twenty-four in southern Illinois—a total of eighty-four separate points or stations. By far the larger part of our material was obtained, however, from Aurora and Chicago and its suburbs in northern Illinois, from Champaign, McLean, and Knox counties in the central part of the state, and from Jackson, Perry, Washington, Union, and Marion counties in southern Illinois. In these ten counties, indeed, nearly 97 percent of all our collections were made, only 142 of our 1959 lots of specimens coming from the remaining thirty-two counties.

NUMBERS OF SPECIES AND OF SPECIMENS

The total number of species recognized in the state was thirty-four, not counting for the present nineteen specimens as yet undetermined. The number of representatives of these species varied from 2 specimens of *hirtiventris* to 43,439 of *hirticula*. Our collections of the sixteen most abundant species amounted, in fact, to 97.9 percent of the total number of the thirty-four species, and those of the ten most abundant species amounted to 91 percent. In the northern section of the state we took 15,457 May-beetles, belonging to twenty-one species. The five most numerous of these species were represented by 84.8 percent of the entire number, and the nine most numerous, by 98.2 percent. In the central part of the state we collected 78,915

May-beetles belonging to twenty-seven species, the first four of which, in order of numbers, were represented by 91.1 percent of the whole and the first six by 98.2 percent. In southern Illinois our 20,121 specimens belonged to twenty-eight species, the first nine of which were represented by 87.2 percent of the specimens and the first fourteen by 97.2 percent.

It is evident from the foregoing that only a comparatively small number of these species of our rather long list have, in any section or location, any special significance either as economic or ecological factors in the general system of life, and to these more abundant species principal attention must be given.

MAY-BEETLES OF THE THREE SECTIONS OF THE STATE
IN THE ORDER OF THEIR ABUNDANCE*

<i>Northern Illinois</i> (15,457 specimens)	<i>Central Illinois</i> (78,916 specimens)	<i>Southern Illinois</i> (20,120 specimens)
Fusca, 4356	Hirticula, 40,484	Forbesi, 3,367†
Futilis, 3197	Implicata, 14,222	Hirticula, 2,874
Rugosa, 2326	Inversa, 9,762	Micans, 2,671
Anxia, 1959	Fusca, 7,442	Implicata, 2,040
Inversa, 1259	Futilis, 4,547	Bipartita, 1,719
Implicata, 718	Tristis, 1,037	Fraterna, 1,448
Ilicis, 560	Rugosa, 410	Vehemens, 1,405
Tristis, 523	Ilicis, 234	Profunda, 1,335
Drakii, 279	Fervida, 174	Fervida, 682
Hirticula, 81	Drakii, 142	Futilis, 556
Nitida, 76	Crassissima, 97	Crenulata, 503
Crenulata, 54	Anxia, 82	Corrosa, 475
Micans, 19	Crenulata, 73	Tristis, 324
Congrua, 14	Horni, 66	Congrua, 175
Forsteri, 9	Fraterna, 58	Delata, 106
Villifrons, 8	Vehemens, 21	Ilicis, 79
Prunina, 8	Prunina, 19	Anxia, 75
Fraterna, 6	Forbesi, 13	Crassissima, 68
Balia, 3	Micans, 10	Forsteri, 60
Corrosa, 1	Bipartita, 6	Praetermissa, 55
Fervida, 1	Balia, 5	Rugosa, 33
	Calceata, 2	Longitarsa, 15
	Barda, 2	Arkansana, 11
	Congrua, 1	Calceata, 8
	Forsteri, 1	Drakii, 8
	Villifrons, 1	Prunina, 6
	Profunda, 1	Barda, 3
	Undetermined, 3	Hirtiventris, 2
		Fusca, 2
		Undetermined, 16

*The nomenclature of this list, and of course of the entire paper, is that of Dr. Robert D. Glasgow, as given in Article V, Vol. XI, of the Bulletin of the Illinois State Laboratory of Natural History. (For synonymy see column of remarks in table on p. 239.)

†Special collection of 352 specimens obtained in 1911 not included.

IMPORTANT SPECIES, GENERAL LIST FOR THE WHOLE STATE

Hirticula,	43,439,	central and southern
Implicata,	16,980,	" " "
Fusca,	11,800,	northern and central
Inversa,	11,021,	" " "
Futilis,	8,300,	" " "
Forbesi,	3,380,	southern
Rugosa,	2,769,	northern
Micans,	2,700,	southern
Anxia,	2,116,	northern
Bipartita,	1,725,	southern
Fraterna,	1,512,	"
Vehemens,	1,426,	"
Profunda,	1,336,	"

108,504 = 94.9 percent of 114,493

METHODS OF COLLECTION

With the exception of those picked up from the ground in following the plow, our May-beetles were, of course, all collected at night, those at light-traps and electric lights early in the evening, as a rule, when the beetles were flying freely, and those from trees and shrubs generally after the night coolness had made the insects sluggish and ready to fall to the ground when jarred or shaken off. Generally speaking, no attempt was made to select the trees and shrubs from which collections were made, but possible food-plants of the beetles were taken indiscriminately, as my collectors chanced to come to them. The 1906 collections and a part of those of 1911 are exceptions to this statement. Records were made in every case of the date, place, and method of collections, and, if obtained from plants, of the kind of plant from which each lot of specimens was gathered.

It was not possible to assign any single assistant or group of assistants to this work, but those favorably situated were instructed to use for this purpose all the time left them from their other employments. The product of the work was, consequently, very unequal in character as to numbers of specimens obtained in different years, at different places, and in different parts of the season. The data are especially difficult to organize in any thoroly satisfactory manner because the only available unit, the single collection (by which is meant the lot of specimens obtained by one person in one night from a single kind of tree or shrub), was not by any means of uniform or equal value at all times and places, and in the nature of the case could hardly be made so even tho great pains were taken to that end. It has seemed to me, however, that, with a sufficient number of collections from food-plants, this unitary value might approximate closely enough to an equal average to make it available for cautious statistical use, provided conclusions are drawn only where contrasts are obvious and pronounced. Such use as has been made of the numbers of beetles obtained from lights has had reference only to time and place, and not to the number of "collections" recorded.

ACKNOWLEDGMENTS

My grateful acknowledgments are due to the considerable number of assistants who made the collections upon which this study is based. Those to whom I am indebted on this account are James A. West, John J. Davis, George E. Sanders, Wesley P. Flint, Horace F. Hudson, Lindley M. Smith, Alexandre A. Girault, David K. McMillan, Charles A. Hart, and George B. Howard. To Dr. Wm. A. Nason, of Algonquin, McHenry county, I am under obligations for twenty-three collections (1280 specimens) obtained at lights in 1907. I am also particularly obliged to John J. Davis, of the U. S. Bureau of Entomology, for data of collections made in northern Illinois in 1914, by means of which I have been enabled to distinguish with certainty the species of May-beetles which were chiefly concerned in a general and serious injury to farm crops by white-grubs in that part of the state in 1912. The determination to species of the large mass of materials brought together was almost wholly the work of another group of assistants, viz.: J. Douglas Hood, James Zetek, Harry C. Severin, and Robert D. Glasgow, and of John A. Grossbeck, of New Jersey, assistant at the time to Prof. John B. Smith, of Rutgers College.

DISCUSSION OF THE SPECIES

In the following summaries of my data concerning our Illinois May-beetles, I have taken the species up in the order of the numbers collected, the most abundant species first, and have given for each such information as I have concerning their numbers in different years in each of the three main divisions of the state, the places from which the principal collections were made, the periods of their occurrence in the beetle stage, and the plants on which they were taken, with the numbers or ratios from each kind of plant.

Phyllophaga hirticula Knoch

Hirticula, altho nearly wanting in our northern Illinois collections,* is much the most abundant May-beetle in the state, comprising nearly 38 percent of all our specimens. Only 81 of our 43,439 specimens of the species came from northern Illinois, and this is only about half of 1 percent of all our May-beetles from that section of the state. In central Illinois, on the other hand, nearly 52 percent of our collections, and in southern Illinois about 14 percent, were of this species. In central Illinois, indeed, we found it nearly three times as numerous

*Among 4,794 May-beetles obtained by J. J. Davis at Galena, in northwestern Illinois, May 28 and 31, 1914, were 758 specimens of *hirticula*. It is possible that this central and southern species extends farther north along the Mississippi than elsewhere, a supposition consistent with what is said on another page concerning the extension of southern species into central Illinois along the watercourses.

as the next most abundant species (*implicita*), and in southern Illinois it was surpassed in numbers only by *forbesi*, for which we made so special a search in midsummer that our recorded numbers of it are probably disproportionate. This predominance of the species in central Illinois is not due to excessive numbers in any one year, but is well marked in four of the six years during which our field work was done. While the central Illinois ratios of *hirticula* for 1907 and 1909 are only 9.1 and 12.8 percent respectively, those for the four remaining years range from 56.9 to 70 percent, with an average of 64.7 percent.

I do not find in these general data any clue to the life history of the species, but this must be found, if anywhere, in the May-beetle population of smaller areas than one of the principal divisions of the state. Such an examination of our more local data shows us that *hirticula* was not abundant at Urbana in 1906; that it was nowhere dominant in 1907; that it was immensely dominant in central Illinois generally in 1908, and possibly at Carbondale, in southern Illinois also, where 349 of the 1242 of our specimens of Phyllophaga were of this species; that it was perhaps subdominant in McLean county in 1909; that it was strongly dominant in 1910 at Galesburg and distinctly so (with *inversa*) at Urbana (*hirticula*, 871; *inversa*, 715), and also at Carbondale, at which latter place, however, its numbers were approached by *micans* and *vehemens* (*hirticula*, 1813; *micans*, 1379; *vehemens*, 1267); and that at Urbana it was strongly dominant in 1911, comprising nearly two thirds of the 10,203 specimens collected there, but followed at some distance by *inversa* (2107 *inversa* to 6501 of *hirticula*). As only 102 May-beetles were collected in central Illinois in 1913, the fact that 58 of these belonged to *hirticula* probably has little importance. Its prevalence in central Illinois in 1908 and again in 1911 is consistent with the supposition that it has a three-year life cycle; but as this apparent periodicity in seasons of unusual abundance might well be due to other causes, we are thrown back upon breeding experiments for this detail of the life history.

Our earliest open-air collections of *hirticula* have been made from April 28 to May 10 in different years in central Illinois and from April 4 to 18 in southern Illinois, and our latest collections from June 30 to July 21 for the central section and from June 17 to 23 for the southern. The periods of the greatest abundance of the species have extended from about the middle of May to the middle of June for central Illinois, and from the last of April to the last of May for the southern part of the state.

By following the plow in central Illinois, my field assistants have obtained from the ground 822 specimens of *hirticula* in many fields at twenty-six dates between April 6 and June 16, as well as 15 more specimens on the 16th of July. The April-June series were probably

hibernating beetles which had transformed the year before, but those taken in July were most likely newly transformed from pupae of the year, not to come up from the ground until the following spring. In northern Illinois, where but few collections were made behind the plow, one of these beetles was found in the ground April 22, and in southern Illinois nine were taken on the same date.

Quite consistently with its general abundance, *hirticula* is a rather general feeder. Among the trees and shrubs on which we have found it present in large numbers at night are oak, blackberry, mountain ash, cherry, hickory, black walnut, persimmon, and birch—abundantly in the order named—, and, in smaller but still considerable numbers, gooseberry, linden, poplar, elm, and willow. It has also occurred occasionally, and perhaps only accidentally, on apple, plum, box-elder, ash, and maple. In a systematic special collection made at Urbana May 14 to June 28, 1906, from four food plants only—that is, oak, elm, poplar, and willow—342 specimens of *hirticula* were taken, of which 309 were from oak. An examination of my table on page 252 will show that this species had a larger percentage of its numbers on oaks than twelve of the fourteen other species of that table, and a smaller percentage than two. It was, in other words, third in the order of apparent preference for the oak; and it was also third on the list of hickory species and on blackberry—facts which bring it clearly into the oak-hickory group of May-beetles. On the other hand, it is sixth on poplar, persimmon, and elm, and thirteenth on willow. Its ratios on the other plants of our list are too small to serve as indications of its choice of foods. The trees and shrubs which it seems to frequent by preference are so numerous and so generally distributed in central Illinois that it can scarcely need to go far for food from any field in which it may originate, and the effort to poison it by spraying its food plants seems therefore practically hopeless. It is, on the whole, one of the most dangerous species in the state.

Phyllophaga implicita Horn

Sixteen thousand nine hundred and eighty specimens of *implicita* are in our Illinois collections—nearly 15 percent of our six years' total for the May-beetle genus. This is next to the most abundant species in the state, surpassed only by *hirticula*. Like that species, it is relatively poorly represented in the northern part of the state, where it made 4.5 percent of our total number of May-beetles for the period. In central Illinois, on the other hand, it made 55.5 percent, and in southern Illinois, about 10 percent, of those collected in these sections. Taken year by year in central and southern Illinois, we find this species making, in 1906, 72.2 percent, and in 1907, 36.6 percent of the total of our central Illinois collections—virtually all in both years from Champaign county; in 1908, 6.1 percent; in 1909,

78.8 percent (4541 *implicita* out of 5758 of all species); in 1910, 5.5 percent; and in 1911, .8 of 1 percent (88 of *implicita* in a total of 10,203). The recurrence of a strongly marked *implicita* year in east-central Illinois in 1909, after the great preponderance of the species at Urbana in 1906, is consistent with a three-year life cycle for the species. In southern Illinois our ratios were: 1907, 3.8 percent; 1908, 4.4 percent; 1909, 22.2 percent; and 1910, .6 of 1 percent. A notable feature of the southern Illinois record is the dominance in the south of *implicita* in 1909, when it was overwhelmingly dominant in central Illinois also.

Our earliest dates for *implicita* in northern Illinois vary from May 20 to 28 in the different years, and our latest, from June 6 to 25, the period of greatest abundance coming from the last two or three days of May to about the 10th or, in one case, to the 21st of June. Our central Illinois dates of earliest appearance range from April 27 to May 15, and those of latest occurrence, from June 5 to July 1. The time of its greatest abundance commonly fell between the last days of May and the middle of June or a little beyond, but in the relatively early season of 1906, it came between May 17 and June 4. In southern Illinois we have found the beetles out as early as April 21 and as late as July 1, with the month from May 20 and June 21 as the time when our collections of the species were largest.

Implicita is unusually definite in its choice of food, being rather closely limited to apple, poplar, and willow. Of our 15,724 specimens of this species collected from food-plants within our six-year period, 5107 were from poplar-trees, 4335 from willows, and 4279 from the apple—92.5 percent of the whole number from these three kinds of trees. The remaining 8.5 percent were divided in only insignificant numbers over twenty-four other kinds of trees and shrubs, the largest ratios being from oak and elm, 1.5 percent for each. In 1906, when 2517 specimens of this species were obtained in collections regularly made from only four kinds of trees, 2311 of them were from poplars and willows, and 206 from oaks and elms.

The contrast in food habits between this species and *hirticula*, both widespread thruout the state and extraordinarily abundant especially in central Illinois, is interesting and suggestive. In the table on p. 252, the relative importance to the species of each food-plant is shown by the ratio which the number of specimens taken from the plant bears to the total number of the species collected from food-plants of all descriptions. Since the main features of the food are the only ones of any significance in this comparison, ratios of less than 1 percent are indicated only by a check. From this table it will be seen that 30,213 specimens of *hirticula* and 15,724 of *implicita* were the numbers obtained from food-plants during our six years' collections; that oak and hickory are represented in the food of *hirticula* by 43.6 percent and 18.8 percent respectively, blackberry giving the

next largest ratio of 9.2 percent; and that in the ratio for *implicita*, oak is represented by 1.6 percent and hickory and blackberry by less than 1 percent. The principal food resorts of *implicita*, on the other hand, were apple, poplar, and willow, represented by nearly equal ratios and frequented by 92.6 percent of our specimens. The corresponding ratios for *hirticula* were poplar, 2.4 percent, willow, 2.9 percent, and apple, less than 1. It is evident that these species, seemingly so closely associated over our whole territory, have a different ecological distribution, the one frequenting oak and hickory uplands primarily, and the other, cottonwood and willow lowlands.

It seems quite possible that this destructive May-beetle, the second species in the state for abundance, might be effectively poisoned by spraying, in May, poplar and willow-trees, if these were so distributed and grown over one's premises as to attract the beetles to them and, by regular replacement of old trees by young ones, kept small enough to be readily reached with a convenient spraying equipment.

Phyllophaga fusca Froelich

Fusca is a distinctly northern species, 4356 of our 11,800 specimens collected coming from northern Illinois, 7442 from central Illinois, and but 2 from the southern part of the state, at Carbondale and Anna. Within its area it is one of the more abundant species, giving us 12.5 percent of the total number of all our collections from the northern two thirds of the state. It is one of our earliest May-beetles, appearing in 1910 as early as April 9 in central Illinois, and in northern Illinois April 14. It commonly continues numerous to the middle of July, its period of adult activity thus covering some three months.

Our 1907 collections were made chiefly in Champaign county, and in McHenry county at Algonquin. In northern Illinois there was no indication that 1907 was a *fusca* year in the districts represented by these points. In 1908, however, it was the leading species at Aurora, altho *futilis* crowded it closely for the dominant position. In Cook county its numbers, altho small, were nearly double those of *futilis*—the next most numerous species in our collections of that year. In 1910 it was subdominant at Aurora and in Cook county, being second in both places to *anxia*. In central Illinois (Urbana and Galesburg) it was also subdominant, second only to *hirticula*, which was, however, more than six times as abundant. In 1913 it was dominant at Aurora and Rockford, and subdominant in Cook county, where it was exceeded by *anxia* and *futilis*. Its predominance in Cook county and at Aurora in 1910 and again in 1913 indicates a three-year cycle for this species. It is a rather indiscriminate feeder, found by us at various times in large numbers on apple, ash, blackberry, poplar, and walnut. In respect to the ratios of its numbers on its different food-plants, it stood first among our species on ash, walnut, hazel, and

gooseberry, third on poplar, fourth on elm and blackberry, fifth on apple, sixth on hickory and willow, and eighth on oak. It is apparently the species whose larvae were mainly responsible for the heavy injury to crops in northern Illinois in 1912, as shown by its numbers in Davis's collections there in 1914. It was then the leading species in that part of the state, comprising more than 60 percent of the 13,521 May-beetles obtained by him there that year.

Phyllophaga inversa Horn

Inversa is limited to northern and central Illinois, and is especially abundant, apparently, in the central part of the state, where it made 12.4 percent of all the May-beetles of our collections, as compared with 8.8 percent in northern Illinois. Curiously, not a specimen of this species was found among the more than 20,000 obtained by us in the southern part of the state. In northern Illinois it was fifth in point of numbers, being surpassed there by *fusca*, *futilis*, *rugosa*, and *anxia*, while in central Illinois it was the third species, only *hirticula* and *implicata* being more numerous.

In 1907 *inversa* was a dominant May-beetle in Champaign county, where it made 27 percent of our collections and was second only to *implicata* (*implicata*, 6964; *inversa*, 5157). In 1908 and 1909 we found no evidence of its dominance anywhere, our northern Illinois material containing only 4 percent of *inversa* in 1908 and 7 percent in 1909; and our central Illinois collections, 2.4 percent and 4 percent in those years, respectively. In 1910 it was again dominant, with *hirticula*, in Champaign county, 39.7 percent of our collections there belonging to *hirticula* and 32.6 percent to *inversa*. The same was true, however, in 1911, when *hirticula* contributed 63 percent to our Urbana collections (6501 out of 10,203 specimens) and *inversa* 21 percent. In 1913 it was apparently a dominant species at Aurora, in northern Illinois, second there only to *fusca* (*fusca*, 47 percent; *inversa*, 36.6 percent of our 1940 specimens).

Our earliest captures of *inversa* in northern Illinois varied in different years from April 15 to May 22 and in central Illinois from April 20 to May 9. Its latest occurrences fell between June 21 and July 9 in the northern part of the state and between June 13 and July 5 in central Illinois. Its periods of greatest abundance ranged from the middle of May to the middle of June at the north and from about the middle of April to the last of May in central Illinois.

In respect to its favorite food-plants, *inversa* differs radically from most of our species. It belongs neither in the oak-hickory nor in the poplar-willow groups; on the other hand, it is third on our list of elm species (*anxia*, 33 percent from that tree; *ilicis*, 17.2 percent; and *inversa*, 14 percent); second of our apple species (*implicata*, 32.6, and *inversa*, 19.6 percent); and second also on the blackberry

(*futilis*, 45 percent, and *inversa*, 22 percent). Its next largest ratio was 19 percent on willow, altho it was sixth of the willow May-beetles in order of its relative frequency on that plant, and sixth also among those taken on poplar. Furthermore, it was first among the small numbers collected from the linden, second in the still smaller number from hackberry, second also in our 71 collections from the ash, eighth from the hickory, and twelfth from oaks. Elm, blackberry, ash, and apple seem, from our data, to be its favorite foods.

Phyllophaga futilis Leconte

Futilis was one of the moderately numerous species in Illinois during our period, its numbers amounting to about 7 percent of all our collections. It occurs thruout the state, but we have found it less abundant in southern Illinois than farther north. This and *fusca* were the dominant or most abundant species at Aurora in 1908, and were possibly more distinctly so than at the same place the following year, altho our collections of these species in 1909 were too small to make this certain. Our data are not so distributed in time as to give us any information concerning the length of life of the generation. This is a rather early spring species, sometimes appearing even in northern Illinois by the middle of April and in southern Illinois before the end of March. It is also rather long-continued, not disappearing as a rule in the central part of the state until July is well advanced. Among the 1650 collections of May-beetles from the 45 food-plants which yielded our specimens, we found *futilis* in any considerable number only on blackberry, apple, hackberry, elm, and corn; but, curiously, 73 of 102 specimens from the four food-plants in 1906 were from poplars. Sixteen hundred and thirteen of our specimens were taken in 38 collections from blackberry bushes, and 331 in 58 collections from apple-trees. A larger proportion of *futilis* than of any other species was taken from blackberry. In our list of the fifteen most important May-beetles it stood first, also, on hackberry and corn, second on elm, box-elder, birch, honey-locust, and gooseberry, fourth on apple, ninth on willow, and thirteenth on oak. Its numbers on ash, hickory, and poplar were each less than 1 percent of the whole number of the species obtained from food-plants. The collections from corn were made in a field which had been heavily infested by white-grubs the year before, and the beetles, coming out of the ground in early spring during a cool wet time, fed freely on the young corn, to its considerable injury, without leaving the field.

Futilis was evidently one of the species responsible for very heavy crop injuries by white-grubs in northern Illinois in 1912, as shown by its numbers there in 1914, when it yielded more than 17 percent of all the northern Illinois collections contributed by Davis.

Phyllophaga forbesi Glasgow

Forbesi is a species recently described,* hitherto frequently confused with *ephilida* Say. It is abundant in southern Illinois, and has a considerable additional range in the Southern States. It was obtained by us first at lights in Odin, Marion county, May 21, 1908, and also June 21 of the same year at Thebes, Alexander county, again at lights, and August 10 from the ground in collections made by following the plow. A special search was begun for it in 1909 with the result that 2766 specimens were obtained at Odin, Olney, Ashley, Carbondale, and Anna, the earliest May 21 and the latest August 6. It was most abundant from June 17 thru July to early August. In 1910, 602 additional specimens were collected, July 21 to 25, at Patoka in Marion county and at Carbondale, and 13 were taken July 21 at Urbana, the northernmost point at which the species has been found.

In 1911 an attempt was made to ascertain the limits of its distribution northward, with the result that 352 specimens (which have not been included in my tabulations or summaries) were collected July 27 to August 6 at Centralia, Odin, and Kinmundy in Marion county, at Effingham in Effingham county, at Greenville in Bond county, and at Ramsey in Fayette county, but none were found at Taylorville, Pana, Mattoon, Charleston, Neoga, or Litchfield.

The food of *forbesi* has proved to be as peculiar as its late seasonal period. Of our 2088 specimens collected from their food-plants, 852 were from cherry-trees, 463 from peach, 422 from apple, 29 from persimmon, and 15 from plum—1781 specimens, or 85 percent of the whole, from these various fruit-trees. Except for 58 specimens from the rose, the remaining 15 percent were scattered in small numbers over sycamore-, walnut-, elm-, oak-, hickory-, and willow-trees. It is thus essentially a cherry, peach, and apple species, at least in Illinois. Its larva has not been identified by us, and nothing is known to me of its life history.

Phyllophaga rugosa Melsheimer

Rugosa is essentially a northern species in Illinois, 84 percent of our 2769 specimens having come from northern Illinois, 14.8 percent from central, and only 1.2 percent from the southern part of the state. This was, indeed, the dominant species in northeastern Illinois in 1907, if we may judge by collections from lights made at Algonquin, McHenry county, from June 14 to July 16, 67 percent of our specimens taken there at that time belonging to *rugosa*. It was subdominant the following year in Cook and Kane counties, when it was surpassed only by *fusca* (*fusca*, 35.2 percent; *rugosa*, 18.9 percent), but in the three following years and in 1913 it dropped away to insignificant numbers in our northern Illinois collections—to 7 percent in

*Bull. Ill. State Lab. Nat. Hist., Art. V, Vol. XI, p. 378.

1909 and 1 percent or less in 1910, 1911, and 1913. That this decline was not local merely, is shown by the fact that it affected our numbers for central Illinois also, which fell from 341 specimens in 1908 to 15 in 1909, to 5 in 1910, to 3 in 1911, and to none at all in 1913.

Rugosa is very scarce in Davis's northern Illinois collections made in 1914, and it evidently had no share in the extensive injury done to crops thruout northern Illinois by white-grubs in 1912.

It is a late species in its seasonal appearance, our earliest collections in northern Illinois coming from May 25 to June 14, and those in central Illinois from May 15 to June 12.

It stands first on our list of poplar species, and second among those from willow, where it is surpassed only by *bipartita*. Seventy-one percent of our specimens of *rugosa* collected from food-plants came, in fact, from these two trees. It is eighth on our list from the oak and fourth on that from the blackberry. Of 200 specimens obtained in systematic work on oaks, elms, poplars, and willows, in 1906, 169 were taken on poplars and the remainder on elms. This is apparently a species of minor economic importance.

Phyllophaga micans Knoch

Micans is a persimmon-oak May-beetle with distinctly southern distribution, 2671 of our 2700 specimens having come from that part of the state, with 10 from central and 19 from northern Illinois, the last from Aurora and stations about Chicago. In southern Illinois it is a common species, third in order of abundance there, and making 13.3 percent of all our collections from that section. It was, indeed, our dominant species there in 1907 and 1908, fourth in abundance in 1909, and second in 1910. Our earliest southern Illinois dates for its occurrence are April 4 and 18, and our latest are June 30 and July 12.

Eighty-five percent of the 1431 specimens collected from food-plants came from persimmon- and oak-trees—50.7 percent from the former and 34.2 from the latter. Indeed if we take account of the larger number of collections made from oaks than from persimmons in southern Illinois, and adjust our ratios accordingly, we find that about four times as many of these beetles would have been obtained from persimmons as from oaks if equal numbers of these kinds of trees had been taken. *Micans* thus seems to be essentially a persimmon species.

Phyllophaga anxia Leconte

Anxia (formerly known as *dubia*) is almost as distinctly a northern species as *micans* is a southern one, 1959 of our 2116 specimens coming from the northern part of the state, 82 from central Illinois, and 75 from southern. Five hundred and ninety-three of these beetles were obtained, however, in 1911 and 1913, when we made no southern Illinois collections; and after subtracting these, the ratios for the

remaining years are 90 percent for northern Illinois and 5 percent for each of the other divisions of the state. The species was dominant in northern Illinois in 1910, when it gave us 36.9 percent of all our northern Illinois May-beetles, the one next in abundance (*fusca*) giving us 22.9 percent. *Anxia* was subdominant at the north in 1913, when it was exceeded only by *fusca* and *inversa*. It is apparently a three-year species. In the year of greatest abundance, 1910, it was first collected by us in northern Illinois April 15 and last occurred there June 30, its greatest numbers falling between May 16 and June 16. It was taken by us, however, in that part of the state as late as July 8.

In respect to its food, as shown by 1244 specimens obtained by us from food-plants, it is peculiar in the combination of a preference for elm and willow. It is, in fact, first on our list of species from the elm, in respect of course to its proportionate numbers on that tree. It is fourth on our willow series, and fourth also on our series from the poplar. It is thus essentially a willow-poplar species, with a further exceptional preference for the elm. It was sixth on our list from the apple, third on the cherry, third on the box-elder also, first on the hackberry, second on the linden and the mountain ash, and tenth on the oak. Three fourths of our specimens came, however, from the elm, willow, poplar, and apple.

Phyllophaga bipartita Horn

Bipartita is a southern Illinois species, only 6 of our 1725 specimens coming from central Illinois and none at all from northern. Urbana is at present our northernmost point for the species in this state. In 1907 and 1908 its numbers were very small, only 2 specimens in the former and 46 in the latter, but in 1909, 797 were taken and in 1910, 850, all in both years from a number of stations in southern Illinois, Olney and Odin the northernmost and Carbondale the farthest south. Its seasonal range was best shown in 1910 when our earliest specimens were taken April 15 and our latest June 30. This is primarily a willow species, 86 percent of our 645 specimens from food-plants coming from willows. It has also some tendency to hickory and oak, these two together yielding 12.2 percent additional. The small numbers remaining were found only on persimmon and apple.

Phyllophaga fraterna Harris

Fraterna is another southern species with a very sparse distribution north as far as Chicago. There were 1512 specimens in our six years' product, all but 64 of them from southern Illinois. Fifty-eight came from various points across the state between Danville and Galesburg, and 6 from Aurora, Edgebrook, and Calvary, in Kane and Cook counties. Our earliest date in any year was March 28 in 1908,

and our latest was July 8, also in 1908. *Fraterna* is one of the oak-hickory-persimmon species, especially characteristic of southern Illinois, these three kinds of trees giving us 95 percent of our specimens. Three and five tenths percent came from willows, and a very few from poplars and black walnuts.

Phyllophaga profunda Blanchard

Profunda is strictly confined to southern Illinois, all our 1336 specimens coming from that section except one from Hoopeston, in Vermilion county. This species was especially abundant in the south in 1910, when it made 11 percent of our collections there, being surpassed in numbers only by *hirticula*, *micans*, and *vehemens*. It was first taken that year on April 9, and for the last time July 21. All but scattering specimens, however, came between May 2 and 26. It is to a marked degree an oak-hickory species, 90 percent of our 1083 specimens coming from these two kinds of trees, and another 7 percent from the persimmon.

Phyllophaga tristis Fabricius

Tristis, nowhere very abundant in our collections, is one of the May-beetles most closely limited to a single food-plant, being essentially an oak species. Sixteen hundred and thirty-four specimens were obtained in 130 collections from oak—an average of 9.6 to the collection—only 131 specimens coming from other food-plants, of which hickory was the most important. Nevertheless, it appears from our data that if equal numbers of collections had been made from hickory and oak, the specimens from hickory would have numbered only 3.4 percent of those from oak. Notwithstanding this controlling preference for oak leaves as food, only about 9 percent of the *Phyllophaga* specimens obtained from oaks belonged to this species.

Tristis was obtained thruout the state in collections ranging from Cook to Union counties, numbering 523, 1037, and 324 in those from northern, central, and southern Illinois respectively.

It was curiously limited, however, in its local occurrence, all our specimens from oaks coming from Aurora, Galesburg, Anna, and Carbondale, while large collections made in the same years from these trees in McLean and Champaign counties and small collections from Cook and Perry counties, did not give us a specimen of this species. It was taken infrequently at lights, only 191 specimens of it occurring among 29,752 May-beetles obtained by us from lights and light-traps; and these small miscellaneous collections were distributed like those from their food-plants, except that 24 specimens came from Danville, in Vermilion county, on the eastern border of the state. Evidently the distribution of this species is restricted by ecological conditions other than those connected with latitude and food.

It seems to be a rather early species, occurring in our southern Illinois collections from March 28 to June 21, in central Illinois from May 2 to July 2, and in northern Illinois from May 16 to July 2. Our data of local abundance in different years are not sufficient to give us any definite clue to the length of its life cycle.

Altho the preference of this species for oaks, and the well-known greater injury done by white-grubs to crops growing near forest trees, might lead us to give to it an unusual economic consequence, its numbers are apparently so small that it does not seem likely to do any considerable general injury in any stage.

Phyllophaga ilicis Knoch

Ilicis is a minor species represented here by only 873 specimens which is less than 1 per cent of the grand total of our collections. It is distributed thruout the state, but seems somewhat the most abundant in northern Illinois, where it amounted to nearly 4 percent of our whole number collected. It was, indeed, dominant in the northern section, together with *futilis*, in 1909, making 27 percent of our 2073 northern Illinois specimens for that year to 37 percent of *futilis*. It is a comparatively late species to appear in spring, our earliest captures coming between May 2 and 26 and our latest between June 16 and July 13.

It is a rather general feeder, with a marked preference, however, for oaks. It is, in fact, the third of our fifteen principal May-beetles in the size of its ratios on oaks, greatly surpassed by *tristis* and a trifle only by *hirticula*, but very nearly equalled by *fervida* and *fraterna*. Its next strongest preference seems to be for elm, in respect to which it is second only to *anxia* (*anxia*, 33 percent; *ilicis*, 17.2 percent). On the other hand, its numbers on poplar and willow, altho relatively small, were too large to be merely accidental. In the four-food-plant series of 1906, 317 out of 351 specimens were from oaks, and 21 from elms. It was eighth in order of our willow beetles and fifth of those from poplar. It was sixth on blackberry, fourth on ash and black walnut, and second on hazel, hawthorn, and rose. Plum, persimmon, linden, honey-locust, gooseberry, birch, and apple each yielded a few, perhaps merely accidental visitors.

Phyllophaga fervida Fabricius

Fervida, better known under its synonym of *arcuata*, is a southern and central species, only one of our 857 specimens coming from northern Illinois. It was furthermore some fifteen times as numerous in southern Illinois as in central, due account being taken of the different numbers of our total collections from these two sections. It was proportionately much more abundant at the south in 1910 than

in any other of our collection years, but was, nevertheless, even then only fifth among our southern Illinois species in frequency of occurrence. There is nothing peculiar in the seasonal dates of this species. Our earliest southern Illinois captures were made between March 28 and April 17, and our latest from the middle to the last of June. With respect to its food it is like many other southern species—an oak-hickory-persimmon May-beetle, 88 percent of our specimens having been taken from these trees. Some 10 percent from willows and 2 percent from ash account for the small remainder.

Phyllophaga vehemens Horn

Vehemens, represented by 1426 specimens, is a typical southern species in Illinois, only 21 coming from central and none from northern Illinois. The central Illinois specimens were collected in Macon and McLean counties in 1907, 1908, and 1909; in southern Illinois we have taken the species at many points from Belleville to Shawneetown and Cairo. All but 36 of our specimens were collected at lights, and we have no sufficient data for a discussion of the food of the species. About nine tenths of our *vehemens* collection was obtained at Carbondale in 1910, mainly between March 27 and April 15, additional scattering specimens occurring up to May 24. This seems to be the earliest in spring of all our May-beetles, altho occasional captures of it have been made by us up to July 1. *Vehemens* was among the dominant species in southern Illinois in 1910, where it was exceeded only by *hirticula* and *micans*, but its numbers in the three other years of our southern Illinois collections have been but few. Its food, as already remarked, is practically unknown.

The foregoing sixteen species are represented by 112,118 specimens, thus amounting to nearly 98 percent of our Illinois collections. The remaining eighteen species are represented by only 2356 specimens in all—too few to give their numbers any important ecological or economic significance. It seems, nevertheless, incumbent upon me to report such facts as the record contains, as hints or clues which may be of use to other entomologists. These remaining species will be treated, like those preceding, in the order of their numbers in our collections.

Phyllophaga crenulata Froelich

Crenulata was represented by 630 specimens, 503 of which were from southern, 73 from central, and 54 from northern Illinois. It is thus distinctly a southern species, as is most clearly seen from the ratios of its numbers in each section of the state to the total for the state as a whole. These are, respectively, 79.8 percent for southern, 11.6 percent for central, and 8.6 percent for northern Illinois. It

showed, during the years covered by our southern Illinois collections, no conspicuous fluctuations in abundance. So far as we may judge from the 255 specimens collected from plants, *crenulata* seems to be a persimmon species, with willow and hickory as second choices. One hundred and five of our specimens (41 percent) were taken from persimmon trees, 41 (16 percent) from willows, and 25 (10 percent) from hickory—two thirds of our little collection from these three trees. A unique additional feature is the occurrence of 22 specimens in four collections from poison ivy. Elm, grape, and hackberry are represented by small numbers, and oak by still smaller.

Phyllophaga corrosa Leconte

Corrosa is represented by 476 specimens, only 1 of which was from northern Illinois, all the rest coming from the southern part of the state. The earliest date of capture was April 9 in 1910, and the latest, July 2, in 1907. Ninety-five specimens taken from food-plants show that *corrosa* is clearly an oak-hickory-persimmon species, with persimmon apparently preponderating as food. All the specimens were taken from these plants except 2 from blackberry.

Phyllophaga drakii Kirby

Drakii, commonly labeled *grandis* in collections, is northern in its Illinois distribution, only 8 of our 429 specimens having come from the southern part of the state. Its increasing abundance northward is shown by the fact that our central Illinois collections amount to less than 2 percent of our total for that part of the state, while those for northern Illinois were nearly 18 percent of the northern Illinois total.

This species is evidently late in appearance, our earliest dates generally coming from the middle to the end of May. We have, however, one capture made April 21 in central Illinois, and another May 2 in the southern part of the state. Our latest specimens were obtained from the middle to the end of June, with the exception of one on July 7.

The food of *drakii* seems to be highly composite, if we may judge from our 378 specimens collected from trees and shrubs. The species was taken most frequently on willow, poplar, oak, elm, hazel, and blackberry, in ratios diminishing from 20 percent on willow to 13.5 percent on elm and 9.8 percent on blackberry, the total for these seven plants being 86.4 percent. Other plants resorted to, by small numbers of the beetles, were rose, ash, gooseberry, mountain ash, birch, honey-locust, raspberry, apple, hawthorn, plum, box-elder, and Viburnum.

Phyllophaga congrua Leconte

Congrua is also a species of somewhat general distribution in the state, with a strong tendency southward, however, where 175 of our 190 specimens were captured in 1907, 1908, and 1909. In two of these years, indeed, none were taken outside of southern Illinois. In the third year, fourteen came from northern Illinois and one from central. Our dates of occurrence range from May 12 to July 7. Our notes on the food-plants of the species are limited to 66 specimens, 65 of which were obtained from willows and 1 from the oak.

Phyllophaga crassissima Blanchard

One hundred and sixty-five specimens of *crassissima* were collected in central and southern Illinois during the four years 1907 to 1910, at dates ranging from May 21 to June 28. All came from lights except 1, taken April 6 behind a plow, and 10 from various plants—in numbers quite too small to give us any useful hint of the food of the species.

Phyllophaga delata Horn

Delata is apparently a southern species, all our 106 specimens having come from southern Illinois in 1908, 1909, and 1910. The earliest date of collection was April 15 and the latest June 30, both in 1910. Altho we obtained but 29 specimens from food-plants, the fact that 16 of these came from hickories, 12 from oaks, and 1 from the persimmon, seems sufficient evidence that this is an oak-hickory species.

Phyllophaga nitida Leconte

Our specimens of *nitida* are only 76, all from northern Illinois in 1907 and 1908. Seventy-five of these were taken at Aurora in the latter year, 73 of them from hazel bushes, and 2 from lights. Our only other specimen was from Algonquin, in McHenry county, July 6. The Aurora specimens were captured at various dates from May 25 to June 9.

Phyllophaga forsteri Burmeister

Forsteri, for which *nova* is a synonym, is represented with us by 70 specimens, of which 60 were southern, 1 central, and 9 northern in this state. It was taken in each of the first four years of our period at dates ranging from May 18 to June 18. Sixty-two of the 70 were collected from food-plants, 42 of them from oaks, 12 from hickories, 7 from persimmons, and 1 from the willow, a clear indication that this is one of the oak-hickory-persimmon group of the southern part of the state.

Phyllophaga horni Smith

Horni was obtained by us only from central Illinois in the years 1908 and 1909, 64 specimens in the first year and 2 in the second, from May 17 to June 21. Forty-six of our specimens were from food-plants, 36 of these from blackberries, 4 from oaks, 2 from poplars, 1 from willow, 2 from cherry, and 1 from elm.

Phyllophaga praetermissa Horn

Praetermissa is apparently a distinctly southern species, represented, it is true, in our materials by 55 specimens only, but all of these coming in three different years from the southern part of the state at dates ranging from May 14 to June 22. They were well distributed from Odin, Ashley, and Duquoin to Shawneetown on the Ohio. Only 26 of our specimens were from food-plants, 13 of them from oak, 9 from willow, and 4 from apple.

Phyllophaga prunina Leconte

Prunina is represented by small scattering collections made during three years in all parts of the state and amounting to only 33 specimens. The fact that 3 were from oaks and 1 from hickory gives us only a hint of the probable character of its food.

Prunina was surprisingly abundant among May-beetles collected near Chicago for Mr. J. J. Davis in 1914, where 2142 of this species were taken in a total of 16,550. I am informed by Mr. Davis that this is characteristically a species of sandy situations, a fact which will account for its general scarcity in Illinois.

Phyllophaga longitarsa Say

Longitarsa, represented with us by 15 specimens, was taken only at lights in Grand Tower, Jackson county, July 12, 1909. We have thus no hint of the character of its food.

Phyllophaga arkansana Schaeffer

Arkansana was represented by a single collection of 11 specimens taken from lights at Ashley, Washington county, May 4, 1908.

Phyllophaga villifrons Leconte

Our 9 specimens of *villifrons* came from northern and central Illinois, 8 from lights at Algonquin, June 14 to July 8, and 1 from an oak at Galesburg, June 4.

Phyllophaga balia Say

We obtained but eight specimens of *balia*, all from the northern and central sections of the state at various dates between April 28 and June 8. They were from birch, hazel, apple, and gooseberry, but in numbers too small to give any definite indication of the food of the species.

Phyllophaga barda Horn

Our 5 specimens of *barda*, obtained from April 25 to May 26, 1908, at Danville, Carbondale, and Anna, in central and southern Illinois, were all from lights.

Phyllophaga calceata Horn

Calceata was obtained by us only in 1907, 2 specimens from the central part of the state and 8 from the southern part, May 22 to June 27, all at lights.

Phyllophaga hirtiventris Horn

Hirtiventris is represented by but 2 specimens from Metropolis, on the Ohio River. They were obtained from lights June 22, 1908.

The foregoing accounts for all our collections of the years mentioned, except some twenty specimens not yet satisfactorily determined.

THE SPECIES BY SECTIONS OF THE STATE

Northern Illinois Species.—In northern Illinois there were but three species, *rugosa*, *anxia*, and *nitida*, so far limited to that section that they may properly be called northern species. *Rugosa* yielded us from northern Illinois 2326 specimens out of 15,457 of all species collected there, 410 specimens out of 78,916 from central Illinois, and 33 out of 20,120 from southern Illinois—numbers equivalent to 15 percent, .52 of 1 percent, and .16 of 1 percent from the three sections, respectively. As a poplar-willow species its ecological affiliations lie northward rather than southward, but its food-plants are common enough, at least along watercourses, in central and southern Illinois to permit its extension into those areas. *Anxia*, a May-beetle of diversified food habits, distinguished by its preference for elm but otherwise mainly a willow-poplar species, occurs thruout the state, but it gives from northern Illinois a percentage of specimens a hundred and twenty-seven times as large as that from central Illinois and over forty times as large as that from southern Illinois; that is, our northern Illinois collections of *anxia* were 12.7 percent of the total number of May-beetles there, and the corresponding ratios for the other two sections were .1 of 1 percent for the central and .37 of 1 percent for

the southern sections. *Nitida* seems even more distinctly northern, if we may judge from our small collections, entirely from Aurora and Algonquin, and nearly all from hazel thickets in the forest border.

Northern-Central Species.—Three of our May-beetles, *fusca*, *inversa*, and *drakii*, altho most abundant northward and virtually absent from southern Illinois, are sufficiently at home in the central district to warrant our grouping them as northern and central species. *Fusca*, for example, which gave us 28.2 percent of all our northern Illinois May-beetles, yielded also 9.4 percent of those from central Illinois, but virtually none from farther south. The corresponding ratios for *inversa* were 8.8 percent northern, 12.4 percent central, and none southern; and for the much less abundant *drakii* they were 1.8 percent, .18 of 1 percent and .04 of 1 percent respectively. Otherwise stated, for each 1000 of *drakii* taken in northern Illinois we might expect, in an equal number of similar collections, 100 from the central part of the state and 2 or 3 from the southern. What physiological or ecological conditions limit the distribution of these species southward it is impossible to tell without much more detailed and intensive ecological work than has thus far been attempted by us. We may only note that all three of these species have a diversified food habit, and belong to neither of the great groups of poplar-willow or oak-hickory-persimmon species.

Central-Southern Species.—Two of our species, *hirticula* and *fervida*, common to central and southern Illinois, are nearly wanting to the northern part of the state. *Hirticula*, a decidedly general feeder with an apparent preference for oak and hickory, has a much larger representation in southern Illinois than in central, making more than half our total collections in the former and less than 15 percent in the latter. Its numbers in northern Illinois we found quite insignificant; altho 11.6 percent of the Galena May-beetles collected by Davis in 1914 were of this species. *Fervida*, on the other hand, was much more distinctively southern, giving us 3.4 percent of our southern Illinois May-beetles and a little over 1 percent of those from central Illinois, with only a single specimen from farther north. It is an oak-hickory-persimmon species.

Southern Illinois Species.—The eleven properly southern Illinois May-beetles are all species of the southern states which find their northern limit in the southern part of Illinois. They are a fairly uniform group in respect to their food, as is shown by the following list of their principal food-plants.

Bipartita: willow, hickory, oak.

Corrosa: persimmon, oak, hickory.

Crenulata: persimmon, willow, hickory.

Delata: oak, hickory.

Forbesi: cherry, peach, apple.

Forsteri: oak, hickory, persimmon.

Fraterna: oak, hickory, persimmon.

Micans: persimmon, oak.

Praetermissa: oak, willow, apple.

Profunda: oak, hickory, persimmon.

Vehemens: food unknown.

COMPARISON OF THE SECTIONS OF THE STATE

The greater diversity of surface and variety of ecological situation shown in southern Illinois, with its level prairies of gray silt loam to the north changing gradually into the broken country of the Ozark hills at the south, bordered on the west by the broad bottomlands of the Mississippi and on the south by the Ohio, create local conditions whose wide diversities are reflected in the various composition and ratios of their insect inhabitants. Central Illinois, on the other hand, has a much more monotonous topography and a May-beetle population more uniformly distributed. Our May-beetles from Anna in the years 1908 and 1909 were much less like those from Carbondale, only seventeen miles away, than were those of Galesburg like those at Urbana, a hundred and twenty-four miles apart but both in the central Illinois prairie region. The five most abundant species in 1908 were the same at the latter two towns, differing only slightly in the order of their numbers, which amounted, at each place, to 99 percent of the May-beetles collected at these points in that year; while in southern Illinois only two of the five most abundant species at Carbondale and Anna were common to both lists. The first and second of the Anna list were ninth and tenth of the Carbondale list, the third at Anna was the second at Carbondale; the fourth was the first, and the fifth was the fourteenth.

Looking in some detail at the extension of distinctively southern species into central Illinois, we find that it is especially notable at points where central Illinois streams are bordered by broken woodlands—where, in other words, the ecological conditions approach those of the hill country of the southern part of the state. Danville on the Vermilion, Decatur on the Sangamon, and Havana on the Illinois, are such locations, and here southern species were taken in 1907 and 1908 as follows: at Danville, *crenulata*, *forsteri*, *fraterna*, and *vehemens*; at Decatur, *crenulata* and *vehemens*; and at Havana, *crenulata*, and *micans*,—five of the eleven mainly southern species at one or more of these central Illinois points. The real boundaries of our areas of distribution are, of course, not the artificial lines separating the conventional sections of the state, but they run a highly irregular course, their meanderings guided largely by the location of our streams. The southern species are, however, represented, as a rule, in central and northern Illinois by numbers so small that they can cut no figure in the general mass of the May-beetle population of the central and

northern parts of the state, and are hence of little or no economic interest there.

COMPARATIVE COLLECTIONS AT LIGHTS,
CENTRAL AND SOUTHERN ILLINOIS,
1907 AND 1908

Species	Danville	Decatur	Havana 1907	Anna	Carbondale	Bloomington	Galesburg	Section of state
<i>Anxia</i>	11	0	0	0	0	1	0	N.
<i>Barda</i>	2	0	0	2	1	0	0	C.S.
<i>Bipartita</i>	0	0	0	0	9	0	0	S.
<i>Calceata</i>	0	0	2	0	0	0	0	S.
<i>Congrua</i>	0	0	0	16	0	0	0	S.
<i>Corrosa</i>	0	0	0	0	123	0	0	S.
<i>Crassissima</i>	0	0	4	0	0	0	0	C.S.
<i>Crenulata</i>	56	1	11	0	105	0	0	S.
<i>Delata</i>	0	0	0	0	3	0	0	S.
<i>Drakii</i>	1	0	0	0	0	2	0	N.C.
<i>Fervida</i>	139	0	0	0	35	0	0	C.S.
<i>Forsteri</i>	1	0	0	0	1	0	0	S.
<i>Fraterna</i>	1	0	0	2	52	0	0	S.
<i>Fusca</i>	187	97	0	0	0	97	40	N.C.
<i>Futilis</i>	79	35	0	181	32	9	37	Gen.
<i>Hirticula</i>	591	198	21	48	340	386	235	C.S.
<i>Horni</i>	12	0	0	0	0	5	0	?
<i>Ilicis</i>	23	0	1	23	5	0	2	Gen.
<i>Implicita</i>	195	8	3	9	35	129	29	C.S.
<i>Inversa</i>	79	0	0	0	0	99	30	N.C.
<i>Micans</i>	0	0	9	19	317	0	0	S.
<i>Profunda</i>	0	0	0	0	87	0	0	S.
<i>Rugosa</i>	200	35	5	0	2	3	11	N.
<i>Tristis</i>	24	1	0	8	12	0	7	Gen.
<i>Vehemens</i>	15	15	0	0	66	0	0	S.
Totals.....	1,616	390	56	306	1,225	731	391	

We notice a much greater similarity of food habit in the southern species than in the northern—oak, hickory, and persimmon being the principal elements of the food of eight of the ten such species whose food we know, the ninth being the peculiar fruit-tree species *forbesi*, and the eleventh, *vehemens*, which we have taken only at lights. Furthermore, *fervida* and *hirticula*, which are southern and central species, are both oak-hickory May-beetles, *fervida* being especially common on persimmon also. The four northern and central species, on the other hand, *ilicis*, *fusca*, *inversa*, and *drakii*, are all of a different food habit from the foregoing group, *ilicis* most abundant on oak and elm, *fusca* and *drakii* rather general feeders, and *inversa* especially abundant on the willow, elm, and hickory.

SEASONAL SUCCESSION OF THE SPECIES

That the different species of May-beetles do not make their first appearance on the wing in spring at the same time is a fact familiar to all collectors, but the actual order of their succession is not easy of determination. Species rare in any locality are much less likely than abundant ones to be taken at the very beginning of their period of activity; even the same species may seem, consequently, to differ in position in the seasonal list in different years according as it is relatively abundant or relatively scarce; the position of a species in the seasonal list may differ in different parts of the state, since the assemblage of species themselves will be different; a species sensitive to cold may be relatively early in the south and yet relatively late in the north, where its activities are restrained by too low a temperature; an apparent difference of date between two species may be due to the fact that collections were not made from their respective food-plants at the same times; if collections from lights are depended on, it may easily happen that the distances from these lights to the places where the different May-beetles breed and emerge most abundantly or to the food-plants on which the different species assemble, are widely different; or the abundance of these food-plants in the neighborhood of the lights may differ so widely that, of equally common species, some may appear in collections abundantly and early and others sparingly and late; the various weather of different seasons and of different parts of the same season may have its disturbing influence; and finally, in our case, these differences of successive years in respect to the distribution of our collections in time, space, and food-plants *must* have introduced differences in succession which are artificial and apparent only. The subject is, nevertheless, sufficiently important to those who would understand the economy of our May-beetle population to make it worthy of careful inquiry.

For this purpose I have prepared tables showing the precise dates on which all our dated collections of each species were made, in each part of the state and in each of the four years from 1907 to 1910 inclusive, the species of each table being arranged substantially in the order of their first appearances in spring. In a few cases this order has been slightly changed where the mass of one species appeared earlier than that of another, even tho the first collections of the latter might have antedated a little those of the former. By a comparative study of these seasonal tables, all necessary allowances being made for differences in abundance of the various species in the collections of each year, it seems possible to arrive at a fairly correct idea of the normal order of succession of the more important kinds of May-beetles for northern, central, and southern Illinois respectively—the succession which would be exhibited if collections were sufficiently numerous and so distributed in space and time as to draw at each collection in

equal ratios from all the species. As the product of such a comparison and adjustment, we may take the following numerical lists of the principal species of each section collected in each year, and the final comprehensive lists showing approximately their general order of succession. These latter lists represent 98 percent or more of the total number of May-beetles from each part of the state. The arrangement of species in the northern and central Illinois lists seems plausibly valid, but the adjustment of the list for southern Illinois is a much more difficult matter, and I am less confident of my success in establishing the correct chronological order there, especially as the ordinal relations of some of the species of the southern list seem different from those of the same species in the list for central Illinois. More reliable data upon this subject might be obtained by general nightly collections made from the very beginning of the season over a considerable area in one or more localities for each section of the state; but until this can be done the following may be accepted as the best practicable with my materials.

SUCCESION OF SPECIES IN NORTHERN ILLINOIS

1907			1908			1909			1910		
Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections
1	fusca	2	1	fusca	1	1	anxia	6	1	fusca	2
2	anxia	5	2	anxia	6	1	fusca	7	2	anxia	1
3	rugosa	1	3	futilis	2	3	tristis	3	3	inversa	6
4	ilicis	3	4	inversa	5	4	inversa	4	4	tristis	8
5	futilis	4	5	implicita	4	5	ilicis	2	5	drakii	7
			6	rugosa	3	6	drakii	5	6	futilis	3
						7	implicita	7	7	implicita	4
						8	futilis	1	8	rugosa	5
						9	rugosa	4			

General Chronological List, Northern Illinois

1, *anxia*; 2, *fusca*; 3, *inversa*; 4, *tristis*; 5, *drakii*; 6, *implicita*; 7, *ilicis*; 8, *futilis*; 9, *rugosa*.

SUCCESSION OF SPECIES IN CENTRAL ILLINOIS

1907			1908			1909			1910		
Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections
1	fusca	3	1	fusca	1	1	hirticula	2	1	fusca	2
2	inversa	1	2	tristis	6	2	implicata	1	2	inversa	3
3	hirticula	5	3	inversa	4	3	fusca	4	3	implicata	4
4	implicata	2	4	hirticula	2	4	drakii	5	4	hirticula	1
5	futilis	4	5	futilis	5	5	ilicis	7	5	tristis	5
			6	implicata	3	6	inversa	3	6	futilis	6
			7	rugosa	7	7	futilis	6	7	fraterna	8
			8	crenulata	9				8	ilicis	7
			9	horni	10						
			10	ilicis	11						
			11	crassissima	8						

General Chronological List, Central Illinois

1, *fusca*; 2, *inversa*; 3, *hirticula*; 4, *tristis*; 5, *implicata*; 6, *futilis*; 7, *rugosa*.

SUCCESSION OF SPECIES IN SOUTHERN ILLINOIS

1908			1909			1910		
Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections	Order of early appearances	Species	Order of numbers in collections
1	micans	2	1	fervida	11	1	vehemens	3
2	hirticula	1	2	vehemens	15	2	tristis	9
3	futilis	3	3	hirticula	5	3	fervida	8
4	vehemens	8	4	rugosa	16	4	fraterna	5
5	fervida	4	5	micans	4	5	futilis	12
6	bipartita	12	6	fraterna	6	6	micans	1
7	fraterna	14	7	corrosa	10	7	hirticula	2
8	implicata	7	8	bipartita	3	8	profunda	4
9	profunda	9	9	profunda	7	9	corrosa	10
10	congrua	11	10	futilis	9	10	bipartita	6
11	crenulata	6	11	praetermissa	14	11	crenulata	11
12	corrosa	5	12	implicata	2	12	implicata	13
13	delata	13	13	crenulata	8	13	forbesi	7
14	anxia	10	14	forsteri	13			
			15	forbesi	1			
			16	congrua	12			

General Chronological List, Southern Illinois

1, *vehemens*; 2, *tristis*; 3, *fervida*; 4, *futilis*; 5, *fraterna*; 6, *micans*; 7, *hirticula*; 8, *bipartita*; 9, *profunda*; 10, *corrosa*; 11, *crenulata*; 12, *delata*; 13, *implicata*; 14, *congrua*; 15, *forsteri*; 16, *forbesi*.

DATES OF COLLECTION, NORTHERN ILLINOIS, 1907

Species	May			June										July										Totals				
	13	17	29	14	15	16	17	20	21	23	27	28	29	30	2	4	5	6	7	8	9	12	13	15				
Fusca....	3	1	1	1	36	12		1	1		1	3	4	22	3	12	28	1	2	2	1				135			
Drakii....		1		1									1			1		1							5			
Anxia....			3		3			1		1	3	2	1	4	1	18	11			1					48			
Villifrons.				2	1																							
Rugosa....				1	313	292	6	4		28	14	15	6	36	9	27	38	13	25	14	4				8			
Illeis....				4	2							1	2	12		31	9	2	5	3								
Futillis....				1	3	4	1	2	1	2	3	7		11	3	37	1	5	1	7	1	2			81			
Crenulata.				1		1	2	2		8				1		1	1	1	1	1	5	2			53			
Inversa....				1	2	1	1					9		8	1	6	1	3	1		1				19			
Tristis....														1	1										33			
NNitida....																	1		1						2			
Prunina....																									1			
Corroasa....																			1		1				1			
Totals..	3	2	4	11	360	309	10	10	2	39	21	37	13	95	18	97	89	25	36	25	57	8	3	1	1,275			

Species													July		Aug.	Totals
	18	19	20	21	22	23	24	25	26	27	28	29	1	7	27	
Futillis..		11	4	259	246	7	10		2	31			1			1628
Anxia...		2	3	3	1						1					172
Fusca...		8	3	8	3		1								20	1960
Rugosa..	34	95	89	32	141	3	16	3	1	4		8	10	1		1054
Inversa.				1		1										229
Implicita				2											22	275
Drakii..								1	3		6					89
Nitida...																75
Ilicis...																18
Micans...																19
Tristis...																10
Congrua.																14
Prunina.									2							7
Fraterna																1
Balia...																2
Forsteri.																9
Crenulati		2			1											7
Totals.	34	118	99	305	392	11	27	4	8	35	7	8	11	1	42	5569

										Totals
6	19	20	22	23	24	25	26	29	30	
2		1	1		1	1				69
										50
17		2	1							144
3	2									411
17	12	16	8			12		3		430
	4	2	6			7				126
1						1				54
10	5	8	11	4	1	268	11	97	82	637
	1									7
7			47	1	30	12	2			144
										1
57	24	29	74	5	32	301	13	97	85	2073

								Totals
5	16	19	20	21	22	29	30	
1	15	4		11	4	1	1	653
7	2	16		38		1	29	389
18	41	6	1	36		1	14	1045
2	9			8				137
7	13			5	4		2	54
8	9							46
2	5			8				22
1	3			7				13
								1
4	31			201		19	3	256
			73	2				228
2	1			3				8
12	129	26	74	319	8	22	49	2857

DATES OF COLLECTION, NORTHERN ILLINOIS, 1908

Species	May												June																													July		Aug.	Totals																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	11	12	13	14	16	17	18	19	20	21	22	23	24	25	26	27	28	29	1	7	27																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Futillis...	16	3			1	2	4	56	12	5	32	7	10	39	64	15	274	20	433	43	7	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							</

DATES OF COLLECTION, NORTHERN ILLINOIS, 1909

Species	May														June																				Totals	
	11	13	14	15	17	18	21	22	23	24	26	27	28	29	30	1	3	4	5	6	9	11	12	13	15	16	19	20	22	23	24	25	26	29		30
Anxia...	1		5	4				2		3	11		3		3	4	3	12	2			6	3		1	2			1	1		1				69
Fusca...		7	7	2	1		1	1	4	4	8				1		5	6	4			5	2	1											50	
Inversa...				2			2		6	4	2		11		5	1	2	10	2			9	53	8		17		2	1			1			144	
Tristis...				1	2	60	11	15	14	27	46			6	61	21	49	55	30	6		3	4		1	3	2								411	
Ilicis...								3	3	7	23		44		42	35	32	53	10			16	63	29	2	17	12	16	8			12		3	430	
Drakii...								3	1	6	7		8		10	36	9	16	5	1		4	1			4	2	6				7			126	
Implicita...										1			3	2	10	1		5	14		15	1			1						1			54		
Futillis...											1		3	1	6	6	2	8	35	3	3	30	35	5	2	10	5	8	11	4	1	268	11	97	82	637
Crenulata...															1	3	2																		7	
Rugosa...																1		36				1	6	2		7									144	
Fervida...																																			1	
Totals..	1	7	12	9	3	60	14	24	28	48	93	1	72	9	139	108	104	201	102	10	3	89	168	45	6	57	24	29	74	5	32	301	13	97	85	2073

DATES OF COLLECTION, NORTHERN ILLINOIS, 1910

Species	April				May							June																				Totals
	14	15	28	29	6	15	16	18	19	25	27	1	5	7	8	9	10	11	12	13	14	15	16	19	20	21	22	29	30			
Fusca....	88	29	56	44	2	33	97	36	40		74	11	64	1	7	8															653	
Futillis....	1											1	3	38	17	25	2	22	23	83	79	7	2	16		1	38	4	1	1	389	
Anxia....		90				1	175		139	20	125	95	51	2	4	81				30	69	58	41	6			36		1	29	880	
Inversa....		2					69				27		19						7	30		2	9				8		1	14	1045	
Drakii....							7				4		6							1		6						8			137	
Tristis....							9				5		5															5	4		2	54
Hirticula....							6						1										18	9							46	
Ilicis....							4																								22	
Balia....							1																2	3				7			18	
Implicita....													9																		1	
Rugosa....											1					1															256	
Crenulata....																				129		14	31			73	201		19	3	228	
Totals..	89	121	56	44	2	34	368	86	179	20	237	107	161	41	28	115	2	22	30	256	160	122	129	26	74	319	8	22	49	2857		

DATES OF COLLECTION, URBANA, ILL., 1906

Species	May											June											Totals				
	14	15	16	17	21	22	23	24	25	26	30	31	1	2	4	5	6	7	9	15	16	18		21	22	25	28
Fusca....	4	10	8	1					9																		82
Implicata...	149	169	79	309	47	44	432	51	66	239	29	158	149	174	110	60	40	10	46	31	17	88	16	3		1	2537
Ilicis....								3	6	22	11	52	7	26	33	48	15	17	23	60	5	16	1	1		1	351
Futilis....								10	2	5		19			3	17	36									102	
Hirticula...								19	4		1	66	18	16	21	32	9	14	10	20	3	5				242	
Inversa....							4					2														11	
Tristis....																										19	
Rugosa....									2			11	4		4	4	1	21	30	20	30	50	29	7	1	200	
Totals...	153	179	87	310	48	57	468	63	66	281	41	308	178	216	171	145	96	98	109	131	55	164	46	11	1	2	3454

DATES OF COLLECTION, CENTRAL ILLINOIS, 1907

Species	Mar.		May										June										July		Totals	
	28	18	7	8	9	13	17	18	22	25	28	29	30	6	12	12	13	15	16	18	21	27	28	1		5
Fusca.....	11	10	107	343	225	96	8	27	51	76	21	201	65	4	34	12	25	50	7	2					1	1871
Inverso.....		226		9	21	177	7	50	225	263	208	268	95	49	44	12	135	124	133	92					1	2139
Irisids.....									2			3														6
Hirticula...				10	117	7	18	48	25	11	320	119	20	14	87	26	52	33	27	2	19				7	2
Implicata...							1	2	242	150	2	305	26	61	82	318	231	9	3						1	964
Futilis.....							2		38	5	17	297	1	5	67	85	248	89	220	102					1	1437
Vehemens...								1																	4	1296
Bipartita...																										4
Balia.....																										1
Ilicis.....																										1
Anxia.....																										1
Rugosa.....																										5
Crenulata...																										18
Prunina.....																										27
Micans.....																										12
Calceata...																										18
Crassissima.																										2
Totals....	11	236	107	353	256	393	19	107	606	519	259	1,397	407	139	243	213	752	551	418	227	16	58	12	15		7314

												July							Totals	
14	16	17	19	20	21	22	23	24	25	28	29	2	4	7	10	13	16	No ave		
9	1 6	13	34	12	1	3	13	9				1		2					2517	
																			689	
		8	15	12	5	2	3	2											1207	
3	58	142	680	323	591	159	359	30	559	4	15	8	62	13		33	9	33	22811	
1			8		1	1	2												42	
		13	67	109	8	20	8	5	1									5	1047	
3		12	213	10	4	12	48		70										1695	
				31			4		1						1		1	32	272	
						2												3	58	
	1			2		2						2		1				7	64	
																1			52	
																			92	
9	66	188	1018	499	610	201	437	35	642	4	15	8	65	13	4	33	10	1	80	30546

				Totals
3	28	29	30	
	2		1	706
16	37	2	22	4495
				133
				87
4	1			25
	1			6
				135
				2
		1		11
		2		37
10	41	5	23	5637

										July						Totals
1	22	23	24	25	26	27	28	30		1	2	3	11	20	21	
84	1	8	5	5	9	3	1	3				1				1248
2		1	1	2	1	1										944
24	7	6		5	15	1	1	4								633
31		237	19	349	247	133	92	119	77	141	40	17			1	7805
																3
																10
8		3		2	6	1	1			1						329
2			1		2	1		1		1	1			2		315
5		3		5	6	1		2		3						52
																9
																1
4		2		5	6	1		3	1	2						66
1		1														5
						1										1
																1
																13
61	8	261	26	373	293	139	97	126	85	148	42	17	2	14		11435

DATES OF COLLECTION, CENTRAL ILLINOIS, 1908

[illegible]

DATES OF COLLECTION, CENTRAL ILLINOIS, 1909

Species	Apr.	May													June													Totals		
	29	5	8	12	15	17	18	20	21	23	27	28	30	31	1	3	4	5	6	7	10	11	13	21	22	23	28		29	30
Hirticula..	1			13	5	51	9	2	5	158	2	119	2	57	79		67	73	5	35	1	1	9		9		2		1	706
Implicita..	8				1	34	11	3	21	345	79	596	2	131	390	675	172	405	104	59	257	366	235	3	151	336	37	2	22	4495
Fusca....		23		59	9	9	2	1	2	14	2	6	2	1			1			2										133
Drakii....			3							8		15		3	7	3	7			2	2	3	9		1					87
Ilicis....			1							6		2		2	4		1	4		2			2				1			25
Anxia....				83	9		9	3	2		18		1	3											4	1				6
Inversa...														2							4	1								135
Horni....										1							1													2
Rugosa...														1				1					1					1		11
Futillis....															1				4		4		3	23				2		37
Totals..	9	23	4	156	24	103	25	8	28	550	85	739	9	197	481	678	248	500	113	105	272	374	310	26	161	340	41	5	23	5637

DATES OF COLLECTION, CENTRAL ILLINOIS, 1910

[illegible]

DATES OF COLLECTION, SOUTHERN ILLINOIS, 1908

Species	April					May					June					Obs. No.	Totals				
	18	20	21	22	24	25	2	4	12	14	16	20	21	22	23			25	26	29	30
	9	4	5	8	129	59	7	9	19	21	60	127	3	49	39			7	1	1	
Micans.....	5		5	86		51														2	346
Hirticula.....	5		3	5		14															396
Futillis.....	2		1			2			96	1	1	3	13	3	5	11	13			4	242
Tristis.....	2		4	15	1	16			5			4	17	3	2	7	1				22
Vehemens.....	2		3	3		8						29	25		6	68					91
Fervida.....	4		8									2	4		2	2					152
Bpartita.....	1											12			6	6					64
Fraterna.....	1											27	31	2	13	11					54
Implicata.....	1		1		1	5			2	5	1	31	2	18	22	21				13	95
Profunda.....						1					47									2	88
Rugosa.....						1											1				2
Barda.....						1		11													3
Arkansana.....																					11
Congrua.....									16			18		1	36	12	3			31	66
Crenulata.....									6	5		61			14		2			2	134
Ilicis.....									7			4			59	20				1	28
Corrosa.....												67		53		2					146
Delata.....											2										57
Crassissima.....																					2
Anxia.....																	69				71
Prunina.....																					2
Forbesi.....																					2
Forsteri.....																	1				1
Practermissa.....																	4				4
Hirtiventris.....																			2		2
Undetermined																					6
Totals.....	29	4	18	189	2	157	7	29	166	23	52	477	76	79	381	281	29	1	1	54	2087

Speci							July												August			Totals
	24	25	26	27	28	30	1	2	12	15	24	26	27	28	29	5	6	26				
Pervida		2					3												103			
Veheme							1												32			
Hirticul			2																591			
Rugosa																			30			
Micans.	2	35	4		2		18	1											759			
Frateru		1	25		12		7												377			
Corrosa			19																117			
Bipartit	2	5																	793			
Profund			20		1														219			
Fusca..																			1			
Tristis.																			27			
Futilis.		1																	148			
Praeteri																			46			
Anxia..																			4			
Implicit	1					17	1												1821			
Ilicis..																			22			
Crenula	3		7		4	10	11	9					2				3		195			
Forsteri																			47			
Delata.																			15			
Forbesi.				4	1		8	25		14	63	247	411	541	550	331	361		2766			
Crassiss																			10			
Congrus																		2	70			
Calceata																			1			
Longita									15										15			
Total	8	44	77	4	20	27	49	35	15	14	63	249	411	541	550	331	364	2	8209			

June										July		Totals
2	9	11	13	14	16	17	30	21	25			
										1267		
										270		
1	2	8		6	8	5				422		
	23	74	90		10	2	4			1011		
14				57	1	1				124		
										1		
17	8	37	110		20	4	5			1479		
10	14	23	52		1	60				1831		
	23	6			2	4		2		1025		
	24	68	26							210		
				135	26	1	46			34		
										844		
										7		
2		2				1				22		
1	8	24	63		24		6	1		169		
										11		
										1		
44		4		9	16	1				74		
56										56		
								319	270	589		
145	102	246	341	207	108	79	63	322	270	9447		

DATES OF COLLECTION, SOUTHERN ILLINOIS, 1909

Species	Apr.	May																June																July										August			Totals							
	17	13	14	17	18	19	20	21	22	24	25	26	27	28	29	2	3	5	7	8	9	10	11	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30	1	2	12	15	24	26	27	28		29	5	6	26			
Fervida....	2	20	15	3	1	1	10			2		14	1						2	3		3					6		1	14			2																		103			
Vehemens...	7	6	2		1							5						4									3																								32			
Hirticula...		51	46			1			2	20	13	380				44	3		1			4						5	16	3																					591			
Rugosa.....		8	5									15										2																												30				
Micans.....		16	31		1	3	4	10	22	31	20	385				10	2	1	13	6	16	2		2			7		9	106		2	35	4																	759			
Fraterna...		17	5							5	14	67	27			71	5		38			20	2				44		5	12			1	25			12													377				
Corrosa....		18	5								4	71																		5			19																	117				
Bipartita...		3	5	8	54	109	92											298	2	52	109	2								52		2	5																		793			
Profunda...		7	5							1		17	25	4		53						83								3			20			1														219				
Fusca.....			1																												2																					1		
Tristis.....			1								13	11																				2																				27		
Futilis.....				2		7	5	4	37	44	23							18		3																																148		
Praeternissa				1															11	4	14	14				1				1																						46		
Anxia.....					1																	2										1																				4		
Implicita...							1	79	365	20	410	28				4	172	5	2			8	59	112	154				10	368	5		1				17	1													1821			
Ilicis.....										2	16	4																																								22		
Crenulata...										8	2	58				2	24	1				2	7	3	1					1	6	33	3		7			4	10											195				
Forsteri....										2	36					1											8																								47			
Delata.....											2																				1																					15		
Forbesi....													12		2											208																										2766		
Crassissima.																						6																														10		
Congrua....																						5	14	3	46																										70			
Calceata....																						1																															1	
Longitarsa..																																																						15
Totals....	9	146	121	14	58	121	112	93	426	146	551	1044	53	16	2	185	231	316	65	75	139	124	84	131	4	412	70	16	28	560	16	37	8	44	77	4	20	27	49	35	15	14	63	249	411	541	550	331	364	2	8209			

DATES OF COLLECTION, SOUTHERN ILLINOIS, 1910

Species	March					April								May														June										July		Totals								
	27	28	29	30	31	1	4	7	8	9	13	15	29	2	3	9	10	16	17	18	19	23	24	26	27	30	2	9	11	13	14	16	17	30	21	25												
Vehemens...	38	56	134	378	73	66	121	3	135	163		72					8	9	4	23																								1267				
Tristis....		2	2				2		4	6								3																											270			
Fervida....		2	12	6		3	16	3	18	78	2	21	2	17	4		20	48	3		1	76	4	7	3	44	2	1	2	8		6	8	5											422			
Fraterna....		2					2		4	10		10	1	100	6		15	98			174	107	42	22	108	22	85		23	74	90			10	2	4								1011				
Futilis....			2	4			10		2	20			6				5	1										14																	124			
Fusca.....							1																																						1			
Micans....							4		2	165	4	14		112	24		181	270	11	142	42	28	50	174	17	38	17	8	37	110		20	4	5										1479				
Hirticula....							4		2	88	6	17	1	65	12	72	253	225	51	263	42	53	96	380	11	30	10	14	23	52		1	60												1831			
Profunda...														187	25		94	242	4	74																									1025			
Corrosa....										7																																				210		
Delata....							2										2	2			21																									34		
Bipartita...																																															844	
Drakii....														14	571	8		26	8																											7		
Ilicis.....																																																22
Crenulata....																																																169
Forsteri....																																																11
Prunina....																																																1
Implicita....																																																74
Crassissima.																																																56
Forbesi....																																																589
Totals...	38	62	150	888	73	69	160	6	167	544	12	152	581	498	71	72	609	917	93	779	374	194	201	957	151	246	145	102	246	341	207	108	79	63	322	270									9447			

VARYING ABUNDANCE OF THE SPECIES IN DIFFERENT YEARS

An examination of my data of the relative numbers of specimens of the several species in successive years gives little reason to suppose that periods of unusual abundance in any locality are commonly separated from one another by an interval equal to that between successive generations of a species. Times of abundance and scarcity are much too irregular, and either one or the other is often too long continued, to make this a plausible explanation of the facts. In view of the number and effectiveness of the animal and vegetable parasites of white-grubs and of the insect parasites of the beetles, it seems much more likely that parasitism, possibly more or less modified by the weather of the period, is a principal cause of these frequently enormous fluctuations in numbers; and even if a periodicity appears corresponding to the length of the life cycle of an abundant species, it is likely soon to be broken up or set aside by a consequent rapid multiplication of parasitic insects and annelids and the spread of contagious diseases due to parasitic fungi and Protozoa. The practical importance of this conclusion is evident. In the absence of such parasitic disturbances of the normal course of events, a season of injurious abundance would be always followed by another such season after a period of years sufficient to bring the next generation of the abundant species to the same stage of larval activity; and if the species concerned and their life history for the latitude were generally and accurately known, measures of precaution might be taken, especially with crop rotations, of a kind to reduce to a minimum the injuries to be expected. This is indeed the case in Europe, with the Old World representatives of our American white-grubs—the *vers blancs* of the French and the *engerling* of the Germans. There the so-called “flight year” of the beetles or a season of serious injuries by the grubs, may be accurately foretold for any locality and measures taken accordingly; but in Europe no parasites of these insects are known, and in their absence there is comparatively little to interfere with the periodical recurrence of these seasons of their destructive abundance, especially as the species are but two as compared with the thirty-four species in Illinois alone. To understand the probabilities with respect to our American white-grubs it is, in my judgment, at least as important to know the status, at the time, of their most effective parasites as to know the life histories of the May-beetles for all our latitudes and climates. This is especially true because of a latent possibility that the grub and beetle parasites, especially the fungi of disease, may be so cultivated and distributed as to assist materially in the control of the insects—an undertaking in which there have been many failures, but one the possibilities of which have been by no means exhausted. We have lately found, for example, that a new annelid parasite of the grubs is the cause of epidemic destruction of them, and that it

may be readily bred and grown in great abundance and by the simplest methods, on raw egg.

RELATIVE ATTRACTIVENESS OF DIFFERENT KINDS
OF TREES AND SHRUBS TO MAY-BEETLES

The following is a list of the plants from which our Illinois May-beetles were collected from 1907 to 1913, with the number of collections from each kind of plant, the number of specimens which these collections contained, and the average number of specimens per collection.

PLANTS FROM WHICH MAY-BEETLES WERE COLLECTED

Food-plants	No. of specimens	No. of collections	No. per collection	Food-plants	No. of specimens	No. of collections	No. per collection
Apple.....	7,802	68	114	Maple.....	308	11	19
Ash.....	852	73	12	Mountain ash.....	760	12	63
Birch.....	818	44	19	Negundo.....	16	12	1
Box-elder.....	147	30	5	Oak.....	18,162	230	79
Blackberry.....	6,515	55	118	Osage orange.....	1	1	1
Catalpa.....	2	2	1	Peach.....	434	3	145
Cherry.....	1,958	26	75	Persian olive.....	15	7	2
Coffee.....	1	1	1	Persimmon.....	1,849	24	77
Corn.....	402	4	101	Plum.....	171	17	10
Currant.....	19	4	5	Poison ivy.....	22	4	5
Currant, flowering.....	16	4	4	Poplar.....	7,562	104	73
Dogwood.....	44	3	15	Redbud.....	14	2	7
Elm.....	3,861	207	18	Rose.....	476	13	37
Gooseberry.....	864	40	22	Snowball.....	9	3	3
Grape.....	19	2	9	Sycamore.....	77	2	38
Hackberry.....	207	21	10	Syringa.....	6	5	1
Hawthorn.....	399	25	16	Tree of heaven.....	14	7	2
Hazel.....	389	17	23	Viburnum.....	47	7	7
Hickory.....	7,484	178	42	Walnut.....	1,691	50	34
Honey-locust.....	460	48	4	Willow.....	8,733	216	40
Honeysuckle.....	8	1	8				
Hornbeam.....	6	4	1	Food-plants.....	73,656		
Horse-chestnut.....	17	1	17	Miscellaneous.....	3,362		
Lilac.....	10	6	2	Lights.....	35,498		
Linden.....	968	51	19	Plow-furrow.....	1,937		
Locust.....	21	5	4	Data deficient.....	40		
				Total.....	114,593		

In cases where a sufficient number of collections were made to give us a fair idea of the attractiveness of the plant to May-beetles at night, we have the means of a significant comparison of these trees and shrubs as a lure to these insects and a consequent source of danger to the crops of neighboring fields.

If we adopt twenty collections as our minimum number from any kind of tree we may make a list of our common forest, shade, and ornamental trees in the order of their attractiveness to May-beetles. In the following, the number after each name is the average number of beetles per collection taken by us from that tree: oak, 79; persimmon, 77; poplar, 73; hickory, 42; willow, 40; walnut, 34; linden, 19; maple, 19; elm, 18; hawthorn, 16; ash, 12; hickory, 10; box-elder, 5; honey-locust, 4. Making due allowance for the unequal character of the collections unit necessarily used in the computation of my averages, I think there can be no reasonable question of the general meaning of the facts represented by this list, and that we may rely upon these index numbers sufficiently to divide the trees of this list into about five groups, as follows: (a) oak, poplar, persimmon; (b) hickory, willow, and possibly walnut; (c) elm, linden, maple, and birch; (d) ash, hackberry, and hawthorn; and (e) honey-locust and box-elder. Perhaps the only things to regret in this list are the apparent marked preference of May-beetles for the oaks and the indifference of these insects to the box-elder. While our field notes do not make sufficient mention of the various species of oaks to enable me to recognize differences among them as food for May-beetles, some of the most experienced and observant of my collectors tell me that the shingle-oak (*Quercus imbricaria*) and the oaks with rounded lobes to the leaves, like the white and bur oaks, are much more resorted to by the beetles than are the red, black, and pin oaks, and other species the lobes of whose leaves are pointed or bristle-tipped. The most dangerous tree on our list is the poplar or cottonwood, of which the much used Carolina poplar is simply a variety. Certainly in the linden, maple, elm, hawthorn, ash, hackberry, and honey-locust, to which we may probably add the red oak and the pin-oak, we have a sufficient variety of fairly safe trees from which to choose for planting either on the village lawn, the country roadside, or the rural home premises.

PRINCIPAL FOODS OF THE PRINCIPAL SPECIES OF MAY-BEETLES

(Ratios of the number of specimens of each species from each food-plant to the whole number of specimens of each species from all its food-plants)

Col- lections	Specimens from food-plants	Apple	Ash	Birch	Blackberry	Box-elder	Cherry	Corn	Elm	Forage plants	Gooseberry	Hackberry	Hawthorn	Hazel	Hickory	Honey-locust	Linden	Mountain ash	Oak	Peach	Persimmon	Plum	Poplar	Rose	Sycamore	Viburnum	Walnut	Willow	
Hirticula.	30,213	+	73	44	55	30	26	4	207	2	40	21	25	17	178	48	51	12	230	3	24	17	104	13	2	7	50	216	
Implicata.	15,724	32.5	+	2.2	9.2	+	3.3	+	3.8	0	1.6	+	+	+	18.8	+	1.5	1.7	43.6	0	1.7	+	2.4	+	+	0	3.7	2.9	
Fusca....	6,024	7.7	9.1	+	4.7	+	+	0	9.2	+	3.7	0	+	2.7	5.7	+	+	1.2	1.6	0	+	32.5	+	+	+	0	0	27.6	
Inversa...	6,799	19.6	1.6	+	22.	+	+	0	14.	0	+	1.6	+	+	3.5	3.3	5.9	+	10.7	0	+	17.2	+	+	0	+	7.8	16.5	
Futilis...	3,454	9.3	+	1.5	46.	1.5	+	11.	8.8	1.5	1.5	2.1	2.	+	1.4	2.	1.1	+	3.2	0	0	+	2.5	5.1	0	+	+	13.	
Forbesi...	1,793	16.	0	0	0	0	47.	0	2.2	0	0	0	0	0	0	0	0	+	2.2	0	0	+	+	0	0	+	+	5.4	
Rugosa...	608	0	0	0	5.4	2.3	0	0	0	4.3	0	0	0	0	0	0	0	+	1.5	24.2	1.6	+	38.8	0	2.5	+	2.4	+	32.4
Micans...	1,431	2.6	+	+	1.	0	0	0	0	0	0	0	0	+	5.3	+	+	10.7	0	0	2.5	+	0	0	0	+	+	5.2	
Anxia...	1,244	7.4	+	+	1.	1.3	1.1	0	33.	0	0	0	2.7	+	0	+	3.	1.6	4.6	0	0	50.7	0	10.5	0	3.4	0	25.	
Bipartita.	645	+	0	0	0	0	0	0	0	0	0	0	0	0	8.	0	0	4.2	0	0	+	0	0	0	0	0	0	86.	
Fraterna.	1,071	0	0	0	+	0	0	0	0	0	+	0	0	0	35.	0	0	42.	0	0	18.	0	+	0	0	+	+	3.5	
Vehemens	No sufficient data																												
Profunda.	1,083	0	0	1.3	0	0	0	0	0	0	0	0	0	0	38.	0	0	52.	0	0	7.3	0	0	0	0	0	+	+	
Tristis...	1,744	+	+	0	+	+	+	0	+	0	+	0	0	0	2.6	+	0	93.7	0	0	0	0	0	0	0	0	0	+	
Illeis....	621	+	1.3	+	4.2	0	0	0	17.2	0	+	0	2.6	1.8	4.7	+	+	42.2	0	+	+	+	6.3	3.4	0	0	2.1	6.8	
Pervida...	232	0	1.7	0	0	0	0	0	0	0	+	0	0	0	15.1	+	+	41.4	0	0	31.4	0	0	0	0	0	0	10.3	

SPECIAL COLLECTION FROM FOUR FOOD-PLANTS, URBANA, ILL., 1906

[illegible]

PRINCIPAL MAY-BEETLE SPECIES ON PRINCIPAL FOOD-PLANTS

Principal oak species:		Principal fruit species:	
<i>tristis</i> ,	93.7 %	<i>forbesi</i>	{ apple, 16. %
<i>profunda</i> ,	52. "		{ cherry, 47. "
<i>hirticula</i> ,	43.6 "		{ peach, 24.2 "
<i>ilicis</i> ,	42.2 "		{ plum, .8 "
<i>fraterna</i> ,	42.2 "		{ 88. "
<i>fervida</i> ,	41.4 "		
<i>micans</i> ,	34.2 "		
Principal hickory species:		<i>futilis</i>	{ apple, 9.3 %
<i>profunda</i> ,	38. %		{ blackberry, 46. "
<i>fraterna</i> ,	35. "		{ gooseberry, 1.5 "
<i>hirticula</i> ,	18.8 "		{ others, .2 "
<i>fervida</i> ,	15.1 "		{ 57. "
Principal persimmon species:		<i>inversa</i>	{ apple, 19.6 %
<i>micans</i> ,	50.7 %		{ blackberry, 22. "
<i>fervida</i> ,	31.4 "		{ others, 1.6 "
<i>fraterna</i> ,	18. "		{ 43.2 "
Principal willow species:		<i>implicata</i>	{ apple, 32.5 %
<i>bipartita</i> ,	86. %		{ others, 1.2 "
<i>rugosa</i> ,	32.4 "		{ 33.7 "
<i>implicata</i> ,	27.6 "		
<i>anxia</i> ,	25. "		
<i>fusca</i> ,	16.5 "		
Principal poplar species:		<i>hirticula</i>	{ blackberry, 9.2 %
<i>rugosa</i> ,	38.8 %		{ cherry, 3.3 "
<i>implicata</i> ,	32.5 "		{ gooseberry, 1.6 "
<i>fusca</i> ,	17.2 "		{ others, .7 "
<i>anxia</i> ,	10.5 "		{ 14.8 "
Principal elm species:		<i>fusca</i>	{ apple, 7.7 %
<i>anxia</i> ,	33. %		{ blackberry, 4.7 "
<i>ilicis</i> ,	17.2 "		{ gooseberry, 3.7 "
<i>inversa</i> ,	14.2 "		{ others, 1.2 "
			{ 17.3 "

PRINCIPAL KINDS OF FOOD-PLANTS OF MAY-BEETLES
BY SECTIONS OF THE STATE*Northern Species**Fusca*: poplar, willow, oak, hickory, ash, elm, apple, walnut, and others.*Nitida*: hazel.*Anxia*: willow, poplar, apple, oak, and linden.*Northern and Central Species**Inversa*: apple, elm, blackberry, and ash.*Rugosa*: poplar and willow.*Drakii*: willow, poplar, oak, elm, hazel, and blackberry.*Central and Southern Species**Hirticula*: oak, hickory, blackberry, and others.*Fervida*: oak, hickory, persimmon, and willow.

Southern Species

Forbesi: cherry, peach, and apple.

Micans: persimmon and oak.

Bipartita: willow, hickory, and oak.

Fraterna: oak, hickory, and persimmon.

Profunda: oak, hickory, and persimmon.

Crenulata: persimmon, willow, and hickory.

Corrosa: persimmon, oak, and hickory.

Delata: oak and hickory.

Forsteri: oak, hickory, and persimmon.

Practermissa: oak, willow, and apple.

SUMMARY

This paper presents a survey of the species, numbers, dates of occurrence, food-plants, and Illinois distribution of the genus *Phyllophaga* (May-beetles), based on a study of nearly 119,000 specimens collected in forty-two counties in all but one of the nine years from 1905 to 1913 inclusive.

Thirty-four species of May-beetles are recognized in Illinois. They vary greatly in abundance, the above collection containing but two specimens of the rarest species and 43,349 of the commonest. Ninety-one percent of the specimens collected belonged to ten of the species, the other 9 percent being distributed among the twenty-four species remaining.

A detailed discussion of the species, taken separately, shows for each its numbers in each year and in each of the three sections of the state, the dates, in each year, of its first appearance and its greatest abundance, and its comparative numbers on each of its food-plants. By means of the data of numbers and distribution, the dominant and subdominant species are distinguished for each year and district, and the intervals between their periods of greatest abundance are considered with reference to the length of the life cycle of the species concerned.

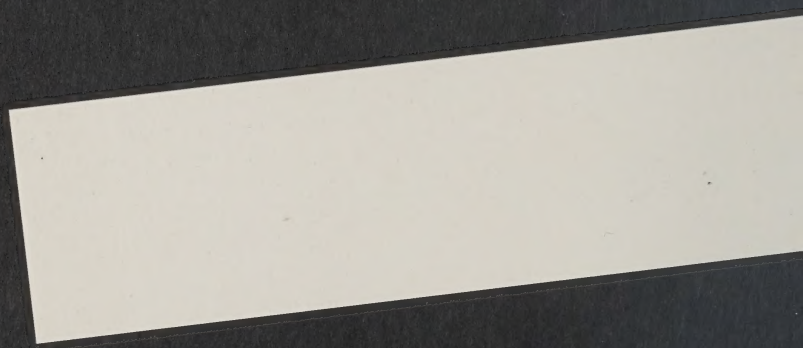
From a comparison of the May-beetles derived from northern, central, and southern Illinois, respectively, it appears that three species are practically limited to northern Illinois, three to the northern and central parts of the state, two to the central and southern, and eleven to southern Illinois. The actual boundary lines between these areas of distribution are, however, irregular and meandering, especially that between southern and central Illinois, which is influenced by the course of the streams, the southern species following them northward towards their headwaters in a way to bring several such species far into the central division of the state.

The seasonal succession of the species—that is the order in which they make their first appearance in spring—is worked out for each section of the state as carefully as the wide distribution and irregular time limits of the collections will permit.

ERRATA

In table on page 239, in column of remarks, against *arkansana* strike out = near *bipartita*; against *calceata* strike out = *rugosa*.

Page 251, line 7, for hickory read hackberry.



Generally speaking, successive periods of extraordinary abundance of a species in any locality or district show little correspondence to any possible life cycle, being too various and irregular for that interpretation. Extensive parasitism of imagos and larvae by insects, annelids, Protozoa, and fungi produces widespread and destructive epidemic diseases, a knowledge of whose prevalence and status is essential to any safe prediction of periods of destructive abundance of the white-grubs.

The May-beetle species known as *Phyllophaga fusca* and *P. futilis* were evidently those which produced most of the white-grubs which were so abundant in northern Illinois in 1912 as to do heavy damage to farm crops in several counties. Two thirds of the collections made in that section in 1914 were of these species, the first of the two mentioned being, however, nearly four times as abundant as the second.

The facts concerning the food-plants of the more abundant species are grouped and classified in a way to distinguish trees and shrubs especially attractive to them, and consequently dangerous to adjacent crops by reason of the abundance of white-grubs to descend from them.



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